MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210 & TERM ID 2215)

PME0016 MECHANICS

(Foundation in Engineering)

18 FEBRUARY 2023
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 3 pages, excluding the appendixes and cover page.
2. Answer all questions.
3. Write your answers in the Answer Booklet provided.
4. Show all relevant steps to obtain maximum marks.

Question 1 (10 marks)

a) State all conditions for equilibrium. [2 marks]

b) Under what conditions are torques positive and negative ? [2 marks]

c) In reference to Figure 1c, the plank is uniform and weighs 500 N.

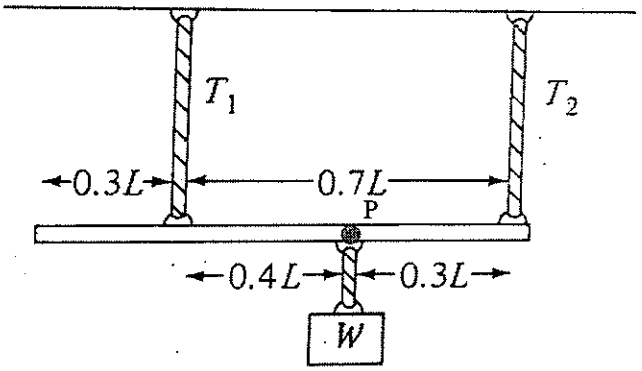

Figure 1c

i) Draw a free body diagram for the plank. [3 marks]

ii) How large must W be if T_1, and T_2, are to be equal?
[Hint: take the axis at P] [3 marks]

Question 2 (10 marks)

a) State the principle of conservation of energy. [1 mark]

b) State the work-energy theorem. [1 mark]

c) A force F of magnitude 10 N acts on an object of mass 2.0 kg placed on a rough horizontal plane, as shown in Figure 2c. The object moves in a straight line at constant speed 15 m/s. The friction force acting on the object can be assumed to be constant. At a particular instant, force F becomes zero. Determine

i) the forces acting on the system. [2 marks]

ii) the velocity of the object after it has travelled through 5.0 m from the moment that force F becomes zero. [4 marks]

iii) the additional distance the object must travel through for it to come to rest. [2 marks]

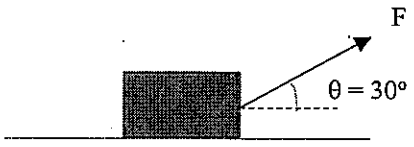

Figure 2c

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Question 3 (15 marks)

a) State or explain the following law, principle or term:

i) Elasticity [1 mark]

ii) Archimedes principle [1 mark]

iii) Stress [1 mark]

iv) Young's modulus [1 mark]

v) Hooke's law [1 mark]

b) A 2.0 m long, 1.0×10^{-3} m diameter wire is suspended from the ceiling. Hanging a 4.5 kg mass from the wire stretches the wire's length by 1.0×10^{-3} m. What is the Young's modulus for this wire?

[3 marks]

c) i) State the application of Archimedes principle. [1 mark]

ii) A frog in a hemispherical pod finds that he just floats without sinking in a fluid of density 1350 kg/m^3 as shown in figure 3c. If the pod has a radius of 0.06 m and negligible mass, what is the mass of the frog?

[Hint: Assume volume of hemisphere and frog are the same. For floating object, the weight and buoyancy are the same , volume of hemisphere, $V = \frac{2}{3}\pi r^3$ and density, $\rho = \frac{m}{V}$]

[3 marks]

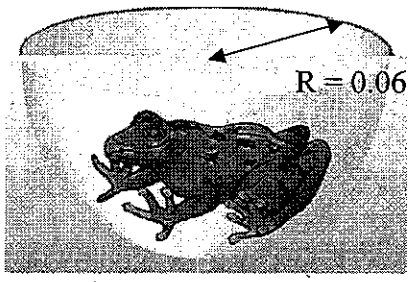

Figure 3c

d) Figure 3d shows the graph of stress against strain for various materials. What are points A, D and E?

[3 marks]

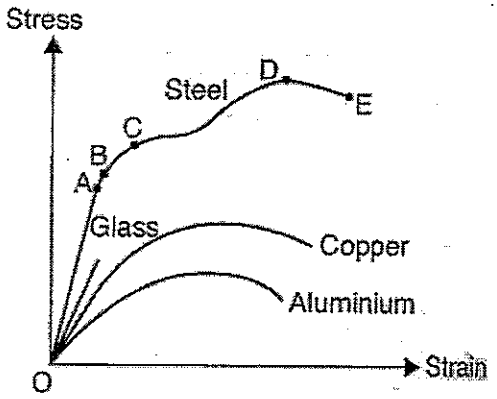

Figure 3d

Continued...

Question 4 (15 marks)

a) Sketch diagram to show how you measure amplitude and period for mass-spring system and pendulum system.
[Hint: sketch both systems and label accordingly]
[4 marks]

b) In a horizontal mass-spring system, the 1.0 kg mass vibrates according to the equation $x = 0.6cos(10.4t)$, where x is in meters, and t is in seconds. Determine the

i) amplitude. [1 mark]

ii) frequency. [1 mark]

iii) total energy. [Hint : first step, obtain the spring constant, k]
[2 marks]

iv) kinetic energy and potential energy when x is 0.30 m.
[Hint: determine the speed at $x = 0.3\ m$, then convert to KE.
Use $E_T = KE + PE$ to get PE]
[3 marks]

v) equation of velocity at any instant of time.
[1 mark]

vi) velocity at t = 1.5 s. [Hint: use the answer in (v)]
[1 mark]

vii) position of the mass when maximum and minimum acceleration is achieved.
[2 marks]

End of page

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^{2}kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 N m^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2 N^{-1} m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.98×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),	R_{ES}	=	149.6×10^6 km
Earth-Moon distance (mean),	R_{EM}	=	385×10^3 km

LIST OF FORMULA

Differential Rule

$$y = kx^n$$

$$\frac{dy}{dx} = knx^{n-1}$$

Trigonometric Identity

$$sin = \frac{opposite}{ypotenuse} \qquad cos = \frac{adjacent}{ypotenuse} \qquad tan = \frac{opposite}{adjacent}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

NEWTONIAN MECHANICS

$$P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = Fv$$

$KE = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_g = mg$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad \omega = \sqrt{\frac{k}{m}}$ $\quad \omega = \sqrt{\frac{g}{l}}$

$T = \frac{2\pi}{\omega} = \frac{1}{f}$ $\quad v_{max} = \omega A$ $\quad a_{max} = \omega^2 A$ $\quad E_T = \frac{1}{2}kA^2$

$v = \omega\sqrt{A^2 - x^2}$ $\quad a = -\frac{k}{m}x$ $\quad \omega = 2\pi f$ $\quad E_T = KE + PE$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$
$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$
$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$\rho = m/V$ $\quad P = F/A$ $\quad B = \rho gV$ $\quad P = \rho gh$

$Y = \frac{FL_o}{A\Delta L}$ $\quad \sum W = \Delta KE$ $\quad \tau = Fd$ $\quad F = ma$